Underlying Event Fluctuations Analysis in the Study of Jets with the ALICE Experiment at the LHC

S-L. Blyth, M.J. Horner, J.L. Klay, G. Odyniec and the ALICE-USA Collaboration

In heavy-ion collisions at LHC energies ($\sqrt{s_{NN}} = 5.5 TeV$), it is expected that a plasma of deconfined quarks and gluons (QGP) will be produced. One of the signatures of the presence of a QGP is the predicted energy-loss of jets (jet-quenching) [1] as a result of traversing the dense nuclear medium. Therefore, jet analysis is considered important in order to probe the properties of the nuclear medium produced in these collisions.

The ALICE experiment at LHC has been designed for heavy-ion physics. With the addition of the USA-proposed electromagnetic calorimeter (EMCal), the range of ALICE physics will be extended to high-p_T and will allow the detailed study of jets in Pb+Pb collisions at $\sqrt{s_{NN}} = 5.5 TeV$.

Jetfinding algorithms used in p+p collisions need to be adapted to accommodate the high-multiplicities (dN/dy $\sim$ 4000) in heavy-ion collisions. Detailed Monte Carlo simulations of jets, the underlying event (BG) and detector response have been performed using PYTHIA[2] events superimposed on HIJING[3] events. 'Pure' BG events were simulated using HIJING. A modified UA1 jetfinding algorithm [4] has been used on simulated data to reconstruct jets.

In order to optimise a jetfinding algorithm for the heavy-ion case, energy fluctuations in the underlying Pb+Pb event (BG) were investigated.
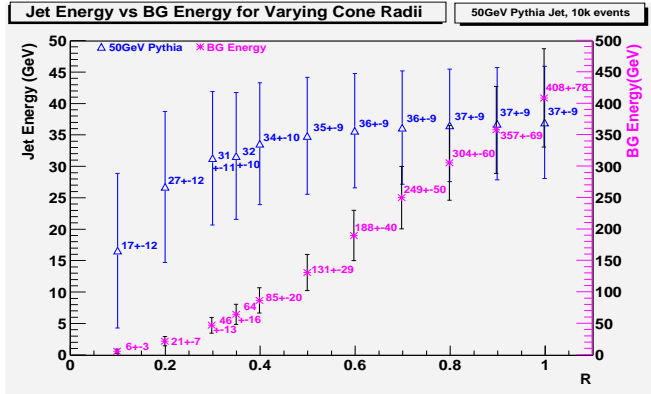

FIG. 1: The points represent the mean energy within a cone of radius R, while the bars show the RMS of each distribution. Triangles indicate jet signal (scale on the left-hand axis), stars indicate the BG contribution (scale on the right-hand axis).

As shown in Fig. 1, the amount of BG energy contained in various cone sizes fluctuates greatly (e.g. 188±40GeV for R=0.6) event-by-event.

Kinematic cuts are chosen to reduce the influence of the BG fluctuations on the jet signal. A p_T cut of 2 GeV/c on primary tracks in the ALICE-TPC has been shown to be optimal for resolution reasons. The introduction of a timecut on simulated data further reduces both the fluctuations and amount of BG energy in the cone by more than a factor of 3 as it reduces the contribution of re-scatterings in the detector materials. Due to the magnitude of the BG fluctuations, they need to be taken into account by the jetfinding algorithm on an event-by-event basis. The fluctuations are also seen to be a function of cone-size, increasing with R,(see Fig. 1). and for large cone sizes ($R \geq 0.5$), the BG fluctuations become comparable to the jet signal. This indicates that smaller cone sizes need to be used in the heavy-ion case compared to the p+p case where typical $R = 0.7$ [5] is used. For analysis of jets of energy 30 GeV and higher, the optimal cone size is found to be $R \sim 0.3$ as shown in Fig. 2.

These modifications to the jetfinding algorithm allow high-p_T jets to be reconstructed even in the high-multiplicity environment at LHC as shown by preliminary jetfinding results for jets of energy larger than 50 GeV in the simulated ALICE framework.
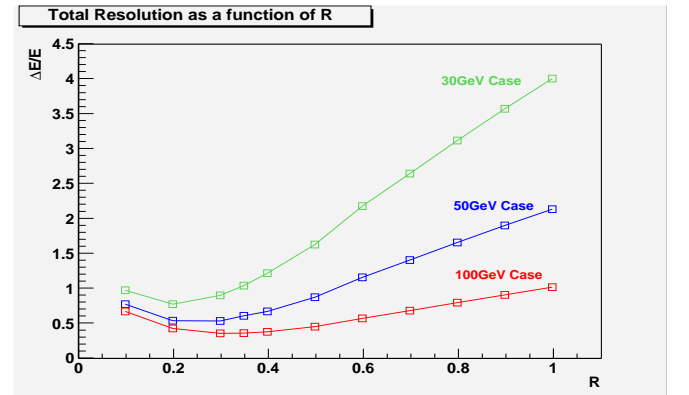

FIG. 2: Resolution vs. cone radius for reconstructing jets of various energies.

[1] X.N.Wang and M. Gyulassy, Phys. Rev. Lett **68**, 1480 (1992)
[2] T. Sjostrand, Computer Physics Commun. **82**, (1994) 74
[3] X.N.Wang and M.Gyulassy, Phys. Rev. D**44**, 3501 (1991)
[4] W.Christie and K Shestermanov, STAR Note 196
[5] Run II Jet Physics, arXiv:hep-ex/0005012